

Two hours - online

The exam will be taken on line.
This paper version is made available as a backup.

**UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE**

Computer Networks

Date: Tuesday 23rd January 2018

Time: 14:00 - 16:00

Please answer all THREE Questions.

Use the SEPARATE answerbook for Diagrams if needed - these will be marked.

This is a CLOSED book examination

The use of electronic calculators is permitted provided they are not programmable and do not store text

[PTO]

- 1)
- a) To create a network application, there are factors that must be considered to maximise its chance of successful long-term deployment. For each of the factors listed below define what the factor means in relation to network applications and why it is important.
- i) Extensibility [2 marks]
 - ii) Heterogeneity [2 marks]
 - iii) Resilience [2 marks]
- b) Describe two approaches that applications use to implement resilience. For each approach, your description must include why the approach gives resilience, drawbacks of the approach and how these drawbacks can be overcome. [5 marks]
- c) Network security aims to achieve certain properties to secure network based communication. For the network security properties listed below describe what they are and why they are important.
- i) Confidentiality [2 marks]
 - ii) Non-repudiation [2 marks]
- d) Alice wishes to send a confidential message to Bob. As Bob has recently been having problems with spam messages, he will only read the message if he can confirm that it comes from Alice and is unaltered. Both Alice and Bob have public/private key pairs and each already know the other's public key. Describe how Alice can send her message in a single transfer with minimal computation cost and be sure that Bob will read the message. [5 marks]

- 2)
- a) There are different classes of multimedia applications. For each of the classes listed below describe what it might be used for and the Quality of Service (QoS) requirements that it has.
 - i) Streamed stored audio/video [2 marks]
 - ii) Streamed live audio/video [2 marks]
 - iii) Conversational audio/video [2 marks]
 - b) A stream on-demand video is being made available to 100's thousands of subscribers. Outline, with justifications, the application-level network infrastructure that will be needed to successfully provide this. [4 marks]
 - c) Multimedia clients can have very different capabilities, e.g. of screen resolution, and access content via networks with different bandwidths. Describe why this means that a multimedia client needs to use a protocol like the Dynamic Adaptive Streaming (DASH) protocol and how they use this to obtain content of the appropriate video quality. [5 marks]
 - d) An application needs to transfer large amounts of time-critical data over a very reliable (but not 100% reliable) network. The application developer has decided that they want to avoid the complexity of ensuring that all of the data sent is received by getting a colleague to develop a new transport layer protocol that provides the minimal delay/minimal overhead Quality of Service (QoS) needs. Outline an approach that the colleague could use to implement reliability in this new transport layer protocol. You should justify why the approach that you describe ensures minimal delay and minimal overhead. [5 marks]

[PTO]

- 3)
- a) The bandwidth available to applications is determined by characteristics at the link/physical level. For each of the characteristics listed briefly state what the characteristic is and why it affects the available bandwidth at the application level.
 - i) Transmission delay [2 marks]
 - ii) Sharing state [2 marks]
 - b) Unfortunately occasionally the network data received will not be the same as what was sent. Describe two techniques that can be used to detect errors. For each of the techniques that you describe, indicate how good it is at detecting errors and its computational cost. [4 marks]
 - c) Justify whether or not it makes sense to do error recovery at the link level. [2 marks]
 - d) Ten network enabled devices are being connected together via a shared access medium. Each device is creating a low volume of network data. Compare and contrast a time or frequency division multiplexing approach to sharing the medium with a carrier sense multiple access (CSMA) approach. You should provide a justified recommendation for the best sharing approach to use. [6 marks]
 - e) Outline the process that allows a mobile user to be located so that they can receive call and/or data sent to them. How can this transfer be made efficient and, if so, what are the downsides of doing this? [4 marks]

END OF EXAMINATION